

4-15-14

US EPA  
Source Test Report

XTO Energy, Inc.  
RBU 11-18F Facility,  
Utah

March 18, 2014  
Permit: EPA Consent Decree  
Engine: Caterpillar G3516LE  
SN: WPW00339  
Unit ID: #2

Prepared By:

Oasis Emission Consultants, Inc.  
2730 Commercial Way  
Rock Springs, WY 82901





April 15, 2014

Ms. Rykki Tepe  
XTO Energy, Inc.  
810 Houston Street  
Fort Worth, TX 76102

Dear Ms. Tepe:

**Re: Engine Emission Testing For XTO Energy, Inc., RBU 11-18F Facility  
Unit #2.**

Oasis Emission Consultants, Inc. was requested to perform an engine emission test on a Caterpillar G3516LE lean burn engine located on tribal land in Utah.

**Emission Levels**

The average recorded levels were found to comply with emission levels stipulated in the guidelines of the EPA Consent Decree, as shown in the attached report, and summarized below.

Emission Unit	Avg NOx	Avg CO
g/BHP-hr	1.11	0.01
lbs/hr	3.12	0.03

**Formaldehyde Levels**

Test Run	HCOH (ppm)	HCOH @ 15% O <sub>2</sub> (ppm)	HCOH @ 15 % O <sub>2</sub> Limit
1	1.80	0.87	14
2	1.84	0.88	14
3	1.90	0.91	14
AVG	1.85	0.88	14

**Catalyst Parameters**

Test Run	Inlet Temp (°F)	DP (in H <sub>2</sub> O)
1	758	12.0
2	757	12.0
3	750	12.0
AVG	755	12.0

### Testing Protocol

The attached report was generated using an extractive FTIR system using methodologies as required by EPA 40 CFR 60 (A) Methods 1-3 and EPA 40 CFR 63 (A) Method 320 and/or ASTM D 6348-03.

### Quality Assurance

Oasis has performed a full cursory review of the raw data and calculated results in this report. Any errors we have encountered have been listed in the body of this report. After performing the review, we are confident that this engine has met the requirements of the Consent Decree.

If you have any questions or require further information, please contact the undersigned at (307) 382-3297.

Yours truly,  
Oasis Emission Consultants, Inc.



Christopher N. Knott, P.Eng.  
Director, Engineering & Operations

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## SOURCE EMISSION TEST REPORT

### PERMIT EPA Consent Decree

Test Performed By:                   Oasis Emission Consultants, Inc.

Facility Name:                         RBU 11-18F Facility  
   Unit #2

Emission Source:                      Caterpillar G3516LE

Date of Test:                          March 18, 2014

Date of Report:                        April 15, 2014

## 1.1 Introduction

The purpose of this source test was to demonstrate that source emissions from a Caterpillar G3516LE engine do not exceed maximum allowable levels specified by guidelines issued in EPA's Consent Decree.

The Caterpillar G3516LE engine is a lean burn engine that employs an Oxidation Catalytic Convertor to regulate emission levels.

Three test runs were performed on March 18, 2014 to analyze NOx, CO & HCOH emission levels according to methodologies outlined in the ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320 Protocol. Effluent exhaust was sampled from the engine through an extractive heated stainless steel sample line interconnected to an MKS 2030 FTIR analyzer.

Each of the three runs consisted of sixty (60) readings taken at one (1) minute intervals.

Test runs were observed by the following individuals:

- Van Welsh, Oasis Emission Consultants, Inc.
- David Rosette, Oasis Emission Consultants, Inc.
- Derrick, XTO Energy, Inc.

## 2.1 Equipment Utilization

The following equipment was used during the tests performed at this facility in conjunction with procedures outlined by ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320.

- (1) MKS MultiGas 2030 FTIR Continuous Gas Analyzer
- (1) Laptop Computer For The FTIR Analyzer Using MKS MG2000 Software
- (1) 30ft or 100ft Heated Teflon Line w/ Heated Sample Probe & Spike Bypass Line
- (1) Fyrite O<sub>2</sub>/CO<sub>2</sub> Analyzer
- (6) EPA Protocol G1 Calibration Gas (CO, NO<sub>x</sub>, C<sub>2</sub>H<sub>4</sub>, CH<sub>3</sub>CHO, C<sub>3</sub>H<sub>8</sub> & NO<sub>2</sub>)

The MKS Multigas 2030 FTIR Analyzer was used to measure NO<sub>x</sub> & CO on a dry basis. Formaldehyde levels were measured on a wet basis and were corrected to produce levels on a dry basis. A pre Direct and System calibration measurement was made on compounds of NO<sub>x</sub>, CO, CH<sub>3</sub>CHO, C<sub>3</sub>H<sub>8</sub> & C<sub>2</sub>H<sub>4</sub>. In addition, a post Direct calibration was made on compounds of NO<sub>x</sub>, CO, CH<sub>3</sub>CHO & C<sub>3</sub>H<sub>8</sub>. A post System calibration was also conducted for C<sub>2</sub>H<sub>4</sub>. Compounds of CO<sub>2</sub>, CO, NO, CH<sub>3</sub>CHO & C<sub>3</sub>H<sub>8</sub> were measured for the quality assurance spiking requirements of ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320

When a gas sample is introduced in the gas cell, the infrared beam is partially absorbed by the gas species present. The spectral frequencies absorbed and their intensity are due to the atoms associated with the chemical bond and the strength of that bond. The absorption spectrum is unique for each infrared-active gas. The MKS Analyzer measures the absorption spectrum, and its analysis algorithm measures the concentration of each gas using pre-loaded calibrations. The MG2000 software allows for the continuous measurement, display and recording of the sample stream.

The MKS Multigas 2030 FTIR Analyzer operated with a spectral resolution of 0.5 cm<sup>-1</sup> and a scan time of 30 seconds. The FTIR spectrometer utilizes a multi-pass gas cell with a 5.11 meter effective pathlength.

## 3.1 Discussion Of NO<sub>x</sub>, CO & HCOH Test Results

Please refer to Appendix A for the raw NO<sub>x</sub>, CO & HCOH test results. Please refer to Appendix B for a listing of all raw data, calibration error response and calculations performed per ASTM & EPA requirements. Overall the average emission levels complied with Consent Decree guidelines on a g/BHP-hr basis. Testing for NO<sub>x</sub>, CO & HCOH were run concurrently with one another.

### 3.1.1 Source Test 1: Caterpillar G3516LE, NOx, CO & HCOH

The first test was performed from 14:54 to 15:53 for NOx, CO & HCOH.

The average NOx and CO levels were found to be **1.15 g/BHP-hr and 0.01 g/BHP-hr** respectively. The Formaldehyde level was found to be **0.87 ppm @ 15% O<sub>2</sub>**, which tested in compliance with the current EPA standards.

Test Run	NOx (ppm)	NOx (g/BHP-hr)	CO (ppm)	CO (g/BHP-hr)	HCOH (ppm)	HCOH @ 15% O <sub>2</sub> (ppm)
1	166.11	1.15	2.40	0.01	1.80	0.87

### 3.1.2 Source Test 2: Caterpillar G3516LE, NOx, CO & HCOH

The second test was performed from 16:00 to 16:59 for NOx, CO & HCOH.

The average NOx and CO levels were found to be **1.15 g/BHP-hr and 0.01 g/BHP-hr** respectively. The Formaldehyde level was found to be **0.88 ppm @ 15% O<sub>2</sub>**, which tested in compliance with the current EPA standards.

Test Run	NOx (ppm)	NOx (g/BHP-hr)	CO (ppm)	CO (g/BHP-hr)	HCOH (ppm)	HCOH @ 15% O <sub>2</sub> (ppm)
2	170.37	1.15	2.42	0.01	1.84	0.88

### 3.1.3 Source Test 3: Caterpillar G3516LE, NOx, CO & HCOH

The third test was performed from 17:04 to 18:03 for NOx, CO & HCOH.

The average NOx and CO levels were found to be **1.02 g/BHP-hr and 0.01 g/BHP-hr** respectively. The Formaldehyde level was found to be **0.91 ppm @ 15% O<sub>2</sub>**, which tested in compliance with the current EPA standards.

Test Run	NOx (ppm)	NOx (g/BHP-hr)	CO (ppm)	CO (g/BHP-hr)	HCOH (ppm)	HCOH @ 15% O <sub>2</sub> (ppm)
3	150.26	1.02	2.56	0.01	1.90	0.91

#### **4.1 Stack Sampling Location**

The sampling port for moisture, flow, NOx, CO and HCOH measurements was approximately 3' from the nearest upstream flow disturbance and 5' from the nearest downstream disturbance.

#### **4.2 Stack Sampling Methods & Procedures**

Testing followed EPA 40 CFR 63(A), Method 320 and/or ASTM D6348-03 methodologies per our standard protocol, with no exceptions.

## 5.1 Quality Assurance

CTS procedures were followed according to ASTM requirements for both pre and post testing. Similarly, QA spiking procedures were followed. Analysis of the CO<sub>2</sub> exhaust effluent was used to determine the dilution factor. Steady levels of the CO<sub>2</sub> were observed and a sufficient duration of time was allowed to elapse for a representative average.

The calibration gas was spiked into the effluent stream using a bypass line at approximately 10% of the sampling rate. The dilution factor was obtained from observation of the stack CO<sub>2</sub> behavior using the following equation:

$$DF = \frac{CO_2_{AVG} - CO_2_{SPIKE}}{CO_2_{AVG}}$$

Where: CO<sub>2</sub><sub>AVG</sub> = The average undiluted CO<sub>2</sub> stack gas concentration of spike measurements  
CO<sub>2</sub><sub>SPIKE</sub> = The average diluted CO<sub>2</sub> stack gas concentration when spiked

The sample recovery was then obtained from the following equation:

$$\frac{\% REC = (Spike_{MEAS} - Stack_{MEAS}) * (1 - DF)}{CS * DF}$$

Where: Spike<sub>MEAS</sub> = The average diluted stack gas concentration when spiked  
Stack<sub>MEAS</sub> = The average undiluted stack gas concentration  
DF = Dilution factor  
CS = Certified concentration of calibration standards

The Sample Recovery average level for CO, NO, C<sub>3</sub>H<sub>8</sub> & CH<sub>3</sub>CHO was found to be 112.6%, 101.3%, 112.4% & 127.7% respectively, which was within the allowable tolerance of Method 320 (70% to 130%). A summary of all spiking procedures/results can be found in Appendix B.

## **APPENDIX A**

XTO Energy, Inc.						
RBU 11-18F #2						
Run 1						
Record	FTIR Measurements				Date	Time
	NOx Dry	CO ppm Dry	Formaldehyde 191C Wet	H2O% (High) 191C		
1	147.94943	2.200478	1.587963	12.884943	3/18/2014	14:54:13
2	154.772708	2.145214	1.45401	11.762369	3/18/2014	14:55:13
3	159.089157	2.074621	1.72423	13.259696	3/18/2014	14:56:13
4	160.730033	2.186974	1.548018	12.964275	3/18/2014	14:57:13
5	158.874878	2.411371	1.375831	10.157754	3/18/2014	14:58:13
6	177.714936	2.443297	1.799426	13.93194	3/18/2014	14:59:12
7	196.329472	2.714404	1.759467	13.1683	3/18/2014	15:00:12
8	166.938713	2.556694	1.820511	12.298732	3/18/2014	15:01:12
9	169.244721	2.586971	1.734574	12.996049	3/18/2014	15:02:12
10	167.332019	2.536947	1.754914	12.637771	3/18/2014	15:03:12
11	163.082601	2.658917	1.319127	9.231494	3/18/2014	15:04:12
12	168.206472	2.680905	1.274227	8.486917	3/18/2014	15:05:12
13	178.039834	2.686446	1.398273	9.536524	3/18/2014	15:06:12
14	180.78869	2.551538	1.58083	10.841875	3/18/2014	15:07:12
15	183.079269	2.499313	1.616899	12.833158	3/18/2014	15:08:12
16	178.588395	2.48199	1.4811	11.289932	3/18/2014	15:09:12
17	179.438115	2.525211	1.450764	11.249975	3/18/2014	15:10:11
18	181.166061	2.437884	1.783297	13.261542	3/18/2014	15:11:11
19	185.77401	2.448109	1.838076	14.830601	3/18/2014	15:12:11
20	174.150238	2.433813	1.951397	14.675344	3/18/2014	15:13:11
21	174.230446	2.429337	1.952025	13.963736	3/18/2014	15:14:11
22	174.831732	2.49525	1.883246	13.192708	3/18/2014	15:15:11
23	167.364994	2.529497	1.609869	11.175817	3/18/2014	15:16:11
24	171.792166	2.451044	1.236417	8.993849	3/18/2014	15:17:11
25	168.42273	2.501889	1.218571	7.722352	3/18/2014	15:18:11
26	171.971549	2.540174	1.084942	6.360677	3/18/2014	15:19:11
27	167.184065	2.461842	1.620296	11.438182	3/18/2014	15:20:11
28	162.953258	2.492179	1.476803	10.61368	3/18/2014	15:21:11
29	159.681707	2.491911	1.507172	11.132458	3/18/2014	15:22:10
30	158.062505	2.547181	1.690335	12.952943	3/18/2014	15:23:10
31	157.272663	2.531486	2.108612	14.832294	3/18/2014	15:24:10
32	161.374756	2.541581	1.877776	12.706002	3/18/2014	15:25:10
33	156.693423	2.489506	2.037565	14.533291	3/18/2014	15:26:10
34	165.03638	2.546238	2.032441	15.617558	3/18/2014	15:27:10
35	171.55898	2.716761	1.751067	12.819118	3/18/2014	15:28:10
36	191.398814	2.918424	1.589426	9.97593	3/18/2014	15:29:10
37	202.757166	2.996229	1.585718	8.044381	3/18/2014	15:30:10
38	214.613371	2.989908	1.4526	9.353106	3/18/2014	15:31:10
39	196.859358	2.91355	1.333757	9.123909	3/18/2014	15:32:10
40	168.051516	2.613238	1.10461	7.805989	3/18/2014	15:33:10
41	153.378922	2.028546	1.482921	11.393067	3/18/2014	15:34:09
42	150.677223	1.920147	1.384922	12.685956	3/18/2014	15:35:09
43	145.691427	1.786437	1.994032	14.410384	3/18/2014	15:36:09
44	144.463475	1.886592	1.789887	13.589186	3/18/2014	15:37:09
45	146.773398	1.664094	1.788131	15.328114	3/18/2014	15:38:09
46	156.393159	1.722969	1.582965	13.132666	3/18/2014	15:39:09
47	143.213962	1.832761	1.34103	12.446817	3/18/2014	15:40:09
48	133.471201	1.945485	1.428575	12.723467	3/18/2014	15:41:09
49	138.127384	1.97182	1.459246	12.696361	3/18/2014	15:42:09
50	140.115834	1.99123	1.419823	12.66875	3/18/2014	15:43:09
51	144.321495	2.050134	1.460153	11.309575	3/18/2014	15:44:09
52	148.36191	2.205486	1.404581	10.287063	3/18/2014	15:45:09
53	153.484115	2.305567	1.36131	10.90454	3/18/2014	15:46:08
54	166.397	2.361783	1.587104	11.814682	3/18/2014	15:47:08
55	170.066353	2.478772	1.434605	10.938282	3/18/2014	15:48:08
56	169.493342	2.471369	1.532303	12.451418	3/18/2014	15:49:08
57	171.374136	2.394656	1.87788	13.559258	3/18/2014	15:50:08
58	167.037331	2.479593	1.75721	13.025656	3/18/2014	15:51:08
59	169.892721	2.611843	1.437897	10.340072	3/18/2014	15:52:08
60	160.506222	2.543132	1.521679	10.891931	3/18/2014	15:53:08
AVG	166.11	2.40	1.59	11.85		

Calculated Emission Levels					
NOx (g/BHP-hr)	NOx (lbs/hr)	CO (g/BHP-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH @ 15% O2 (ppm)
1.15	3.18	0.01	0.03	1.80	0.87

## TEST RUN # 1

EPA REFERENCE METHOD 1		EPA REFERENCE METHOD 2						
Stack Diameter	12 Inches	Kp= 85.49 ft/sec				Cp= 0.84		
Traverse Points	16	Port	Point	Insertion Depth (inches)	dP (in H <sub>2</sub> O)	T <sub>s</sub> (deg R)	Stat P (in H <sub>2</sub> O)	sqrt dP
Ports	2	A	1	0.38	4.01	1168	1.46	2.002
EPA REFERENCE METHOD 3		A	2	1.26	3.76	1168	1.46	1.939
Average O <sub>2</sub>	8.6 (% dry)	A	3	2.33	3.21	1168	1.46	1.792
Average CO <sub>2</sub>	7.1 (% dry)	A	4	3.88	3.11	1168	1.46	1.764
Average N <sub>2</sub> + CO	84.3 (% dry)	A	5	8.12	2.95	1168	1.46	1.718
Dry Molecular Weight	29.48 lb/lbmol	A	6	9.67	2.91	1168	1.46	1.706
Wet Molecular Weight	28.12 lb/lbmol	A	7	10.74	3.01	1168	1.46	1.735
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	8	11.62	4.00	1168	1.46	2.000
Barometric Pressure	24.87 in Hg	A	9					
Moisture Content	11.85 %	A	10					
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	11					
Average Analyzer NO <sub>x</sub> Level	166.11 ppm	A	12					
Calculated NO <sub>x</sub> Mass Output	3.18 lbs/hr	A	13					
Calculated NO <sub>x</sub> Output	1.15 g/BHP-hr	A	14					
ASTM D6348-03 / EPA REFERENCE METHOD 320		B	1	0.38	4.03	1168	1.46	2.007
Average Analyzer CO Level	2.40 ppm	B	2	1.26	3.81	1168	1.46	1.952
Calculated CO Mass Output	0.03 lbs/hr	B	3	2.33	3.67	1168	1.46	1.916
Calculated CO Output	0.01 g/BHP-hr	B	4	3.88	3.30	1168	1.46	1.817
ASTM D6348-03 / EPA REFERENCE METHOD 320		B	5	8.12	2.38	1168	1.46	1.543
Average Analyzer HCOH Level (wet)	1.59 ppm	B	6	9.67	3.05	1168	1.46	1.746
Average Corrected HCOH Level (dry)	1.80 ppm	B	7	10.74	3.44	1168	1.46	1.855
Calculated HCOH @ 15% O <sub>2</sub>	0.87 ppm	B	8	11.62	3.77	1168	1.46	1.942
Calculated HCOH Mass Output	0.023 lbs/hr	B	9					
Calculated HCOH Output	0.008 g/BHP-hr	B	10					
LOAD APPROXIMATION		B	11					
Estimated Engine Load	1259.4 BHP	B	12					
		B	13					
		B	14					
		B	15					
		B	16					
Averages				3.40	1168	1.5	1.840	
Average Stack Gas Velocity				170.35 ft/sec				
Average Dry Flowrate				2670.33 dscfm				

**XTO Energy, Inc.**

RBU 11-18F #2

Run 2

Record	FTIR Measurements				Date	Time
	NOx Dry	CO ppm Dry	Formaldehyde 191C Wet	H2O% (High) 191C		
1	144.054709	2.263699	1.372626	9.216086	3/18/2014	16:00:54
2	142.112	2.246614	1.414415	10.964605	3/18/2014	16:01:54
3	147.42569	2.03869	1.876581	13.943975	3/18/2014	16:02:54
4	157.885126	2.062122	1.500793	12.23299	3/18/2014	16:03:54
5	155.168889	2.010604	1.487871	12.143168	3/18/2014	16:04:54
6	160.22632	2.023095	1.406282	12.130636	3/18/2014	16:05:54
7	159.896839	2.157888	1.745427	12.919821	3/18/2014	16:06:54
8	153.586909	2.216104	1.327352	11.159377	3/18/2014	16:07:53
9	148.024256	2.266131	1.290407	10.444193	3/18/2014	16:08:53
10	142.50227	2.180244	1.377032	11.193005	3/18/2014	16:09:53
11	151.863665	2.226778	1.468778	11.535154	3/18/2014	16:10:53
12	155.576331	2.226219	1.995716	14.490171	3/18/2014	16:11:53
13	172.765799	2.351874	1.481005	11.788974	3/18/2014	16:12:53
14	189.282921	2.483248	1.537705	11.33977	3/18/2014	16:13:53
15	212.85762	2.707919	1.768321	13.319177	3/18/2014	16:14:53
16	184.816441	2.561599	1.873427	15.061339	3/18/2014	16:15:53
17	202.033478	2.584954	2.14318	15.967806	3/18/2014	16:16:53
18	202.464534	2.767042	2.038917	13.401252	3/18/2014	16:17:53
19	197.938022	2.718352	1.825941	12.266332	3/18/2014	16:18:52
20	204.062717	2.781359	1.524578	11.387424	3/18/2014	16:19:52
21	196.798222	2.776093	1.459241	10.070809	3/18/2014	16:20:52
22	172.705545	2.679848	1.561212	9.131279	3/18/2014	16:21:52
23	172.976438	2.616784	1.366323	9.481974	3/18/2014	16:22:52
24	173.64985	2.461451	1.55005	11.418055	3/18/2014	16:23:52
25	181.658833	2.475127	1.539671	12.432086	3/18/2014	16:24:52
26	183.585815	2.295013	1.719257	14.562449	3/18/2014	16:25:52
27	189.126247	2.396239	2.05156	15.626812	3/18/2014	16:26:52
28	193.924556	2.310015	2.10083	15.379929	3/18/2014	16:27:52
29	196.429989	2.396692	1.980939	14.485965	3/18/2014	16:28:52
30	195.571206	2.488278	1.838783	13.814284	3/18/2014	16:29:52
31	195.649614	2.543265	1.696467	13.23041	3/18/2014	16:30:51
32	186.868858	2.565648	1.746408	13.026362	3/18/2014	16:31:51
33	178.559874	2.563502	1.546178	11.489945	3/18/2014	16:32:51
34	172.979182	2.477955	1.491707	11.325264	3/18/2014	16:33:51
35	169.348785	2.514264	1.569235	11.924561	3/18/2014	16:34:51
36	164.469789	2.506462	1.534307	11.037111	3/18/2014	16:35:51
37	162.447647	2.440639	1.513739	11.391474	3/18/2014	16:36:51
38	164.269298	2.469762	1.617156	12.238327	3/18/2014	16:37:51
39	168.337511	2.485058	1.505286	10.687085	3/18/2014	16:38:51
40	172.834659	2.524944	1.423295	10.895079	3/18/2014	16:39:51
41	172.91336	2.49048	1.657422	12.626539	3/18/2014	16:40:51
42	164.039961	2.399352	1.814019	13.293172	3/18/2014	16:41:50
43	158.793548	2.536405	1.687234	12.656369	3/18/2014	16:42:50
44	158.865464	2.637495	1.436851	10.29187	3/18/2014	16:43:50
45	154.843938	2.581865	1.392819	9.669427	3/18/2014	16:44:50
46	155.377737	2.593035	1.374713	10.083003	3/18/2014	16:45:50
47	150.97373	2.597646	1.729968	12.442263	3/18/2014	16:46:50
48	159.047807	2.622468	1.693346	12.492478	3/18/2014	16:47:50
49	170.87995	2.69179	1.644525	11.997289	3/18/2014	16:48:50
50	202.901515	2.838171	1.741681	12.034504	3/18/2014	16:49:50
51	205.510347	2.925461	1.704739	11.535193	3/18/2014	16:50:50
52	182.509681	2.59209	1.662532	11.776808	3/18/2014	16:51:50
53	162.86599	2.492823	1.549422	11.103188	3/18/2014	16:52:50
54	151.335221	2.040006	1.354093	10.419066	3/18/2014	16:53:49
55	148.259954	1.89931	1.28916	10.513766	3/18/2014	16:54:49
56	146.310364	1.946408	1.738837	13.041398	3/18/2014	16:55:49
57	146.349649	2.149356	1.600697	12.395522	3/18/2014	16:56:49
58	149.068623	2.152133	1.465065	11.607592	3/18/2014	16:57:49
59	153.259973	2.141275	1.63322	12.698784	3/18/2014	16:58:49
60	151.097831	2.122262	1.790503	13.446754	3/18/2014	16:59:49
AVG	170.37	2.42	1.62	12.11		

Calculated Emission Levels					
NOx (g/BHP-hr)	NOx (lbs/hr)	CO (g/BHP-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH @ 15% O2 (ppm)
1.15	3.27	0.01	0.03	1.84	0.88

TEST RUN # 2

EPA REFERENCE METHOD 1		EPA REFERENCE METHOD 2						
Stack Diameter	12 Inches	Kp= 85.49 ft/sec				Cp= 0.84		
	Traverse Points	Port	Point	Insertion Depth (inches)	dP (in H <sub>2</sub> O)	Ts (deg R)	Stat P (in H <sub>2</sub> O)	sqrt dP
Ports		A	1	0.38	3.96	1164	1.48	1.990
Average O <sub>2</sub>	8.5 (% dry)	A	2	1.26	3.80	1164	1.48	1.949
Average CO <sub>2</sub>	7.1 (% dry)	A	3	2.33	3.16	1164	1.48	1.778
Average N <sub>2</sub> + CO	84.4 (% dry)	A	4	3.88	3.10	1164	1.48	1.761
Dry Molecular Weight	29.48 lb/lbmol	A	5	8.12	2.90	1164	1.48	1.703
Wet Molecular Weight	28.09 lb/lbmol	A	6	9.67	2.84	1164	1.48	1.685
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	7	10.74	2.96	1164	1.48	1.720
Barometric Pressure	24.86 in Hg	A	8	11.62	3.78	1164	1.48	
Moisture Content	12.11 %	A	9					
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	10					
Average Analyzer NO <sub>x</sub> Level	170.37 ppm	A	11					
Calculated NO <sub>x</sub> Mass Output	3.27 lbs/hr	A	12					
Calculated NO <sub>x</sub> Output	1.15 g/BHP-hr	A	13					
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	14					
Average Analyzer CO Level	2.42 ppm	A	15					
Calculated CO Mass Output	0.03 lbs/hr	A	16					
Calculated CO Output	0.01 g/BHP-hr	B	1	0.38	3.90	1164	1.48	1.975
ASTM D6348-03 / EPA REFERENCE METHOD 320		B	2	1.26	3.74	1164	1.48	1.934
Average Analyzer HCOH Level (wet)	1.62 ppm	B	3	2.33	3.60	1164	1.48	1.897
Average Corrected HCOH Level (dry)	1.84 ppm	B	4	3.88	3.39	1164	1.48	1.841
Calculated HCOH @ 15% O <sub>2</sub>	0.88 ppm	B	5	8.12	3.46	1164	1.48	1.860
Calculated HCOH Mass Output	0.023 lbs/hr	B	6	9.67	3.13	1164	1.48	1.769
Calculated HCOH Output	0.008 g/BHP-hr	B	7	10.74	3.40	1164	1.48	1.844
LOAD APPROXIMATION		B	8	11.62	3.64	1164	1.48	1.908
Estimated Engine Load	1287.0 BHP	B	9					
		B	10					
		B	11					
		B	12					
		B	13					
		B	14					
		B	15					
		B	16					
Averages				3.42	1164	1.5	1.841	
Average Stack Gas Velocity				170.32 ft/sec				
Average Dry Flowrate				2670.34 dscfm				

**XTO Energy, Inc.**

RBU 11-18F #2

Run 3

Record	FTIR Measurements				Date	Time
	NOx Dry	CO ppm Dry	Formaldehyde 191C Wet	H2O% (High) 191C		
1	165.091754	2.569847	1.544449	10.3471	3/18/2014	17:04:19
2	158.879836	2.552566	1.530969	10.935803	3/18/2014	17:05:19
3	157.735171	2.546129	1.601828	11.684472	3/18/2014	17:06:19
4	158.440468	2.489269	1.590166	11.85748	3/18/2014	17:07:19
5	162.646824	2.543237	1.642853	11.798478	3/18/2014	17:08:19
6	169.307299	2.539255	1.592911	11.654859	3/18/2014	17:09:19
7	164.164172	2.566955	1.535172	11.233233	3/18/2014	17:10:19
8	164.072887	2.546262	1.525269	11.329639	3/18/2014	17:11:18
9	160.59085	2.581859	1.611863	11.900155	3/18/2014	17:12:18
10	153.926036	2.655236	1.693219	12.019399	3/18/2014	17:13:18
11	148.403244	2.467528	1.722065	12.174412	3/18/2014	17:14:18
12	147.169509	2.571527	1.75074	12.282764	3/18/2014	17:15:18
13	146.498893	2.589455	1.698458	12.014404	3/18/2014	17:16:18
14	149.870718	2.610422	1.633694	11.784402	3/18/2014	17:17:18
15	148.177942	2.624585	1.668675	11.791607	3/18/2014	17:18:18
16	150.165079	2.591119	1.711321	12.101345	3/18/2014	17:19:18
17	148.648909	2.604324	1.61354	11.475465	3/18/2014	17:20:18
18	153.005234	2.612628	1.495328	10.625224	3/18/2014	17:21:18
19	159.707648	2.649202	1.465774	10.318093	3/18/2014	17:22:18
20	163.923022	2.558194	1.439895	10.373755	3/18/2014	17:23:17
21	159.691217	2.526058	1.544931	11.540601	3/18/2014	17:24:17
22	157.07477	2.559935	1.59867	12.023477	3/18/2014	17:25:17
23	158.656308	2.543432	1.65356	12.010192	3/18/2014	17:26:17
24	161.530567	2.49219	1.663547	12.328782	3/18/2014	17:27:17
25	154.175997	2.526176	1.692948	12.438928	3/18/2014	17:28:17
26	147.882196	2.532705	1.651393	11.829685	3/18/2014	17:29:17
27	142.434988	2.556032	1.564884	11.298132	3/18/2014	17:30:17
28	147.383821	2.55058	1.526327	11.225634	3/18/2014	17:31:17
29	142.875429	2.481297	2.022668	13.104516	3/18/2014	17:32:17
30	137.590362	2.536671	1.96552	13.012288	3/18/2014	17:33:17
31	140.443472	2.546363	1.689478	11.918026	3/18/2014	17:34:16
32	141.33	2.568393	1.640801	11.809209	3/18/2014	17:35:16
33	144.048044	2.637225	1.454288	10.327275	3/18/2014	17:36:16
34	144.742223	2.681475	1.279209	7.910865	3/18/2014	17:37:16
35	141.420261	2.717684	1.801368	9.817012	3/18/2014	17:38:16
36	141.149749	2.542134	1.955891	12.237958	3/18/2014	17:39:16
37	141.140567	2.622808	1.711952	11.286425	3/18/2014	17:40:16
38	139.161371	2.602948	1.883124	12.523288	3/18/2014	17:41:16
39	133.94488	2.497347	1.828173	13.598977	3/18/2014	17:42:16
40	139.755276	2.539506	1.92106	13.290917	3/18/2014	17:43:16
41	141.580016	2.563641	1.876907	13.972677	3/18/2014	17:44:16
42	143.92114	2.545372	1.748238	12.828003	3/18/2014	17:45:15
43	145.542881	2.574211	1.710452	11.730393	3/18/2014	17:46:15
44	151.028493	2.625135	1.81136	12.844985	3/18/2014	17:47:15
45	155.821227	2.552562	1.766054	13.162564	3/18/2014	17:48:15
46	157.987464	2.614425	1.682137	12.572744	3/18/2014	17:49:15
47	155.365174	2.581595	1.741804	12.900287	3/18/2014	17:50:15
48	152.08972	2.534283	1.78364	12.875445	3/18/2014	17:51:15
49	147.893687	2.623148	1.827371	12.882404	3/18/2014	17:52:15
50	142.747125	2.61965	1.869353	12.920282	3/18/2014	17:53:15
51	137.691468	2.572722	1.769399	12.560548	3/18/2014	17:54:15
52	140.702575	2.626756	1.753235	12.114377	3/18/2014	17:55:15
53	145.967373	2.473839	1.667741	12.068245	3/18/2014	17:56:15
54	148.48966	2.489659	1.646643	11.684866	3/18/2014	17:57:15
55	146.489882	2.507406	1.646356	11.926009	3/18/2014	17:58:14
56	144.99639	2.522392	1.669469	12.153208	3/18/2014	17:59:14
57	146.063654	2.422457	1.673798	12.058128	3/18/2014	18:00:14
58	152.811066	2.516185	1.606255	11.645204	3/18/2014	18:01:14
59	154.24589	2.487901	1.667932	11.895412	3/18/2014	18:02:14
60	157.567434	2.448896	1.586331	11.640843	3/18/2014	18:03:14
AVG	150.26	2.56	1.68	11.89		

Calculated Emission Levels					
NOx (g/BHP-hr)	NOx (lbs/hr)	CO (g/BHP-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH @ 15% O2 (ppm)
1.02	2.91	0.01	0.03	1.90	0.91

## TEST RUN # 3

EPA REFERENCE METHOD 1		EPA REFERENCE METHOD 2						
Stack Diameter	12 Inches	Kp= 85.49 ft/sec				Cp= 0.84		
Traverse Points	16	Port	Point	Insertion Depth (inches)	dP (in H <sub>2</sub> O)	T <sub>s</sub> (deg R)	Stat P (in H <sub>2</sub> O)	sqrt dP
Ports	2							
EPA REFERENCE METHOD 3		A	1	0.38	4.04	1160	1.50	2.010
Average O <sub>2</sub>	8.5 (% dry)	A	2	1.26	3.85	1160	1.50	1.962
Average CO <sub>2</sub>	7.1 (% dry)	A	3	2.33	3.26	1160	1.50	1.806
Average N <sub>2</sub> + CO	84.4 (% dry)	A	4	3.88	3.04	1160	1.50	1.744
Dry Molecular Weight	29.48 lb/lbmol	A	5	8.12	2.96	1160	1.50	1.720
Wet Molecular Weight	28.11 lb/lbmol	A	6	9.67	2.81	1160	1.50	1.676
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	7	10.74	3.13	1160	1.50	1.769
Barometric Pressure	24.84 in Hg	A	8	11.62	3.70	1160	1.50	1.924
Moisture Content	11.89 %	A	9					
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	10					
Average Analyzer NO <sub>x</sub> Level	150.26 ppm	A	11					
Calculated NO <sub>x</sub> Mass Output	2.91 lbs/hr	A	12					
Calculated NO <sub>x</sub> Output	1.02 g/BHP-hr	A	13					
ASTM D6348-03 / EPA REFERENCE METHOD 320		A	14					
Average Analyzer CO Level	2.56 ppm	A	15					
Calculated CO Mass Output	0.03 lbs/hr	A	16					
Calculated CO Output	0.01 g/BHP-hr	B	1	0.38	3.97	1160	1.50	1.992
ASTM D6348-03 / EPA REFERENCE METHOD 320		B	2	1.26	3.82	1160	1.50	1.954
Average Analyzer HCOH Level (wet)	1.68 ppm	B	3	2.33	3.71	1160	1.50	1.926
Average Corrected HCOH Level (dry)	1.90 ppm	B	4	3.88	3.43	1160	1.50	1.852
Calculated HCOH @ 15% O <sub>2</sub>	0.91 ppm	B	5	8.12	3.32	1160	1.50	1.822
Calculated HCOH Mass Output	0.024 lbs/hr	B	6	9.67	3.09	1160	1.50	1.758
Calculated HCOH Output	0.008 g/BHP-hr	B	7	10.74	3.46	1160	1.50	1.860
LOAD APPROXIMATION		B	8	11.62	3.71	1160	1.50	1.926
Estimated Engine Load	1294.0 BHP	B	9					
		B	10					
		B	11					
		B	12					
		B	13					
		B	14					
		B	15					
		B	16					
Averages				3.46	1160	1.5	1.856	
Average Stack Gas Velocity				171.44 ft/sec				
Average Dry Flowrate				2701.76 dscfm				

## **APPENDIX B**

## Raw Calibration Data

### BACKGROUND

Date	Time	NO 191C span	NO2 191C span	H20% (high) 191C	Formaldehyde 191C	Ethylene 191C TE span	Propane 191C span	Acetaldehyde 191C span	CO ppm 191C (10f2) span	CO ppm Dry	CO2 191C	NOx Wet	NOx Dry	NM NE HC C3	
3/18/2014	13:08:34	-0.061418	-0.075375	0.010217	0.097159	-0.061947	0.441559	0.09596	0.320662	0.320662	-0.065947	-0.136807	-0.136807	0.026367	
3/18/2014	13:08:41	0.050786	0.012166	0.012897	0.012897	-0.061947	0.432726	0.056255	0.410632	0.410685	-0.065511	0.052034	0.052041	0.024291	
3/18/2014	13:07:53	0	0	0	0	0	0	0	0	0	0	0	0	0	
3/18/2014	13:08:06	0.015083	0.019409	0.004163	-0.082359	0.005931	-0.023948	-0.525475	0.033505	-0.365027	0.020213	-0.00212	-0.00154	0.034492	0.034491
3/18/2014	13:08:13	-0.002508	0.002397	0.005931	-0.023948	-0.297837	0.092549	0.036877	0.10174	0.10174	-0.00212	-0.00154	0.034492	0.034491	
3/18/2014	13:08:21	-0.099409	0.052952	-0.05059	-0.025323	-0.818429	0.607323	-6.129595	0.10172	0.101715	-0.000783	-0.000461	0.000461	0.000536	
3/18/2014	13:08:28	0.048705	-0.021771	0.004929	-0.072391	-0.312303	0.281504	0.324086	0.158499	0.158507	-0.004099	0.028934	0.028934	0.007542	
3/18/2014	13:08:36	0.111189	-0.040323	-0.003477	0.016348	-0.465053	0.30981	-0.374574	0.077971	0.077986	-0.003642	0.070864	0.070864	0.009524	
3/18/2014	13:08:43	-0.047475	-0.034793	-0.004669	-0.080354	0.399348	0.152104	0.383708	0.046473	0.046473	-0.017321	-0.032286	-0.032286	0.006009	
3/18/2014	13:08:51	0.155141	-0.003587	0.000333	-0.160957	-0.547131	0.455373	0.873137	0.057557	0.057557	-0.011391	0.151573	0.151573	0.034014	
3/18/2014	13:08:58	-0.01911	-0.059599	-0.001551	-0.091743	0.011486	0.239362	0.273085	0.089723	0.089723	0.000744	-0.154201	-0.154201	0.005831	
3/18/2014	13:09:06	-0.01911	-0.059599	-0.001551	-0.091743	0.011486	0.64313	0.109835	0.109835	0.109835	-0.013813	-0.104891	-0.104891	0.007879	
3/18/2014	13:09:13	0.031538	-0.056739	-0.004624	-0.069524	-0.790145	0.3857	-0.669527	-0.022288	-0.022288	0.002972	-0.005202	-0.005202	0.017890	

### PRE DIRECT CAL

Date	Time	CO ppm 191C (10f2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span
3/18/2014	13:09:21	108.514813	124.257889	98.753535	3/18/2014	13:16:17	24.547231	3/18/2014	13:11:42	0.40709
3/18/2014	13:09:28	484.040464	488.294954	478.834307	3/18/2014	13:16:25	1.888525	3/18/2014	13:11:49	5.476027
3/18/2014	13:09:36	501.705469	508.338475	501.041143	3/18/2014	13:16:32	88.784426	3/18/2014	13:11:57	24.852953
3/18/2014	13:09:43	502.131707	507.151551	500.812055	3/18/2014	13:16:39	88.784426	3/18/2014	13:12:04	28.226206
3/18/2014	13:09:51	502.669128	507.557009	503.788582	3/18/2014	13:16:47	99.258113	3/18/2014	13:12:12	13.803365
3/18/2014	13:09:58	502.195238	507.468763	503.651098	3/18/2014	13:16:55	99.215308	3/18/2014	13:12:19	28.303363
3/18/2014	13:10:06	502.925303	508.078314	504.621889	3/18/2014	13:17:02	99.658099	3/18/2014	13:12:27	28.373278
3/18/2014	13:10:13	502.795696	507.631201	504.987571	3/18/2014	13:17:09	99.019406	3/18/2014	13:12:34	27.820817
3/18/2014	13:10:21	502.889603	507.915751	507.233555	3/18/2014	13:17:17	98.714837	3/18/2014	13:12:42	27.898906
3/18/2014	13:10:28	503.057451	507.809194	505.731984	3/18/2014	13:17:24	99.533584	3/18/2014	13:12:49	27.761984
					3/18/2014	13:17:32	99.259825	3/18/2014	13:12:57	28.778972

### NO2 CAL

Date	Time	NO2 191C span
3/18/2014	13:14:00	1.238552
3/18/2014	13:14:07	3.289204
3/18/2014	13:14:15	81.805832
3/18/2014	13:14:22	145.041438
3/18/2014	13:14:30	147.277783
3/18/2014	13:14:37	148.006858
3/18/2014	13:14:45	147.929257
3/18/2014	13:14:52	148.181868
3/18/2014	13:15:00	148.118105
3/18/2014	13:15:07	148.242097
3/18/2014	13:15:15	148.181127
3/18/2014	13:15:22	148.7906

### PRE SYSTEM CAL

Date	Time	CO ppm 191C (10f2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span
3/18/2014	14:26:58	140.525026	7.203288	3/18/2014	14:31:49	3.493973	3/18/2014	14:30:21	14:30:21	-0.556148
3/18/2014	14:27:03	2.131317	153.847358	6.827578	3/18/2014	14:31:56	3.541501	3/18/2014	14:30:29	-0.089161
3/18/2014	14:27:11	2.412382	156.401814	7.205218	3/18/2014	14:32:03	6.819338	3/18/2014	14:30:36	0.831283
3/18/2014	14:27:18	212.636373	280.246985	205.760589	3/18/2014	14:32:11	73.891412	3/18/2014	14:30:44	19.9695
3/18/2014	14:27:26	411.126852	417.586402	417.583369	3/18/2014	14:32:19	95.328471	3/18/2014	14:30:51	5.472552
3/18/2014	14:27:33	433.55602	435.57948	441.086055	3/18/2014	14:32:26	97.459055	3/18/2014	14:30:58	26.034253
3/18/2014	14:27:40	439.848336	443.428289	446.817285	3/18/2014	14:32:33	97.75688	3/18/2014	14:31:06	27.883796
3/18/2014	14:27:48	445.537982	449.505353	452.011444	3/18/2014	14:32:41	98.812234	3/18/2014	14:31:13	27.662032
3/18/2014	14:27:55	454.225026	459.052743	462.070761	3/18/2014	14:32:48	97.976198	3/18/2014	14:31:21	28.070124
3/18/2014	14:28:03	462.776931	468.466793	467.891969	3/18/2014	14:32:56	98.219223			
3/18/2014	14:28:10	465.879381	470.533768	472.755851						
3/18/2014	14:28:18	472.045982	475.423779	478.354032						
3/18/2014	14:28:25	472.981892	477.450472	475.813387						
3/18/2014	14:28:33	475.298526	479.797338	481.826989						
3/18/2014	14:28:40	475.789105	479.958982	481.225915						
3/18/2014	14:28:48	479.528007	482.876731	484.336419						
3/18/2014	14:28:55	479.876392	481.861397	482.070417						
3/18/2014	14:28:03	479.885914	484.159175	485.188527						
3/18/2014	14:28:10	478.735543	484.392021	484.430358						
3/18/2014	14:28:18	482.312206	487.517331	485.865718						
3/18/2014	14:29:26	482.822556	490.034937	490.454429						
3/18/2014	14:29:33	485.041358	493.328732	492.62364						
3/18/2014	14:29:40	485.893577	494.073383	493.59922						

## SAMPLE SPIKE RECOVERY

Date	Time	CO2% 191C	CO ppm 191C (1e3) span	NO 191C span	Propane 191C span
3/18/2014	14:44:45	5.90898	1.590029	90.801229	6.87998
3/18/2014	14:45:02	5.956248	1.655058	85.857205	6.18001
3/18/2014	14:45:03	5.952448	1.668348	91.03909	6.03074
3/18/2014	14:45:07	6.095519	1.860028	90.020618	6.480785
3/18/2014	14:45:15	6.103995	1.877797	96.034564	6.64322
3/18/2014	14:45:22	6.128783	1.61934	92.849627	6.35551
3/18/2014	14:45:30	6.153286	1.784812	90.688081	6.803031
3/18/2014	14:46:22	6.330283	1.795797	91.524413	6.901954
3/18/2014	14:46:29	6.348595	1.878529	93.585241	6.724777
3/18/2014	14:46:37	6.360552	1.917525	91.088193	6.808896
3/18/2014	14:46:44	6.347218	1.941087	87.140837	7.079943
3/18/2014	14:46:52	6.422566	1.712851	91.102028	6.296442
3/18/2014	14:47:59	6.438781	1.838388	98.36774	6.83674
3/18/2014	14:48:07	6.380105	1.782237	86.202286	6.813384
3/18/2014	14:48:14	6.36123	44.450849	114.470634	47.627514
3/18/2014	14:48:22	6.048811	380.428531	386.293923	380.273004
3/18/2014	14:48:29	3.847178	170.922274	232.852443	169.739345
3/18/2014	14:48:37	5.679303	60.568134	143.082862	64.52744
3/18/2014	14:48:45	5.876187	49.350946	131.722287	53.04917
3/18/2014	14:48:52	5.925493	48.314046	129.308158	52.955685
3/18/2014	14:48:59	5.928781	47.894888	129.376305	51.48843
3/18/2014	14:49:07	5.93002	47.936989	132.285271	51.17448
3/18/2014	14:49:14	5.927494	47.84595	133.367798	50.048507
3/18/2014	14:49:22	5.853231	53.699234	137.272511	57.892748
3/18/2014	14:49:29	5.558104	71.941703	148.204571	75.601957
3/18/2014	14:49:37	5.561057	74.873202	150.749575	78.098039
3/18/2014	14:49:44	5.575775	75.448275	154.437303	78.661178
3/18/2014	14:49:52	5.593963	75.051471	150.885005	78.62207
3/18/2014	14:49:59	5.692771	70.459741	143.838418	73.51308
3/18/2014	14:50:07	5.723785	66.065656	140.446848	70.699138
3/18/2014	14:50:37	5.93004	58.871165	129.353141	62.369161
3/18/2014	14:50:44	5.472397	57.197032	131.625885	62.369027
3/18/2014	14:50:52	5.586144	57.382597	134.688812	61.51902
3/18/2014	14:50:59	5.684105	57.012099	132.810188	61.308946
3/18/2014	14:51:07	5.49198	57.889427	131.907764	62.012083
3/18/2014	14:51:14	5.528332	57.135316	130.89348	61.898593
3/18/2014	14:51:22	5.635877	56.828508	132.157111	60.05543
3/18/2014	14:51:29	5.747042	49.1449	127.281639	53.485228
3/18/2014	14:52:07	5.86943	45.848196	127.352154	50.52942
3/18/2014	14:52:14	5.815797	45.859573	125.192941	50.57303

## ACETALDEHYDE SPIKE RECOVERY

Date	Time	CO2% 191C	Acetaldehyde 191C span
3/18/2014	14:38:48	6.039693	-0.04808
3/18/2014	14:38:54	6.233785	-0.578833
3/18/2014	14:39:01	6.349832	-0.053401
3/18/2014	14:39:09	6.401806	-0.422587
3/18/2014	14:39:16	6.429791	-0.831488
3/18/2014	14:39:23	6.451985	-0.180523
3/18/2014	14:40:01	6.271187	0.620238
3/18/2014	14:40:09	6.301732	-0.196808
3/18/2014	14:40:16	6.335042	-0.193837
3/18/2014	14:40:23	6.309451	-0.543101
3/18/2014	14:41:01	6.284189	-0.771308
3/18/2014	14:41:08	6.195273	-0.165319
3/18/2014	14:41:16	5.920445	-0.447523
3/18/2014	14:41:23	2.958185	6.290077
3/18/2014	14:41:31	1.451941	19.413638
3/18/2014	14:41:38	4.854395	7.608889
3/18/2014	14:41:46	5.472937	4.106878
3/18/2014	14:41:53	5.885335	3.965133
3/18/2014	14:42:00	5.791482	2.851997
3/18/2014	14:42:08	5.84737	3.05734
3/18/2014	14:42:18	5.853177	3.03884
3/18/2014	14:42:23	5.872281	2.936964
3/18/2014	14:42:31	5.817017	3.517502
3/18/2014	14:42:38	5.788323	3.328895
3/18/2014	14:42:55	5.586733	3.247929
3/18/2014	14:43:01	5.680523	3.181922
3/18/2014	14:43:08	5.71238	3.009395
3/18/2014	14:43:38	5.877972	2.779888
3/18/2014	14:43:49	5.503721	2.591998

## POST DIRECT CAL

Date	Time	CO ppm 191C (1e3) span	NOx Wet	Date	Time	Acetaldehyde 191C span
3/18/2014	18:12:21	0.114791	-0.078472	3/18/2014	18:13:40	0.110475
3/18/2014	18:12:29	212.412158	1.214133	3/18/2014	18:13:48	0.970352
3/18/2014	18:12:36	494.810819	500.284886	3/18/2014	18:13:55	21.90825
3/18/2014	18:12:44	502.450239	508.195176	3/18/2014	18:14:03	28.580415
3/18/2014	18:12:51	503.153929	509.843312	3/18/2014	18:14:10	28.301336
3/18/2014	18:12:59	503.302624	509.904836	3/18/2014	18:14:18	28.247388
3/18/2014	18:13:06	503.940485	509.846814	3/18/2014	18:14:25	28.035708
3/18/2014	18:13:14	603.948009	509.857658	3/18/2014	18:14:33	28.72888

POST SYSTEM CAL

Date	Time	Ethylene 191C TE
3/18/2014	18:05:48	3.637905
3/18/2014	18:05:55	2.598009
3/18/2014	18:08:03	48.567344
3/18/2014	18:08:10	87.324455
3/18/2014	18:08:18	92.784881
3/18/2014	18:08:25	95.369907
3/18/2014	18:08:33	95.508988
3/18/2014	18:08:40	98.863554
3/18/2014	18:08:47	99.910254
3/18/2014	18:08:55	97.783030
3/18/2014	18:07:02	97.581699
3/18/2014	18:07:10	97.232836

### FTIR QA/QC SUMMARY

SAMPLE RECOVERY CALCULATIONS																
Period	Spike #	Concentration of CO Cylinder	Concentration of Propane Cylinder	Concentration of NO Cylinder	Stack CO2 Concentration	Stack CO Concentration	Stack NO Concentration	Stack Propane Concentration	Stack + Spike CO2 Concentration	Stack + CO Concentration	Stack + NO Concentration	Stack + Propane Concentration	DF Calculated	% Recovery CO	% Recovery NO	% Recovery Propane
PRE TEST	1	503.0	503.2	509.7	6.2	1.7	90.9	6.6	5.6	54.3	130.4	58.6	0.093	112.6%	101.3%	112.4%

ACETALDEHYDE SAMPLE RECOVERY CALCULATIONS								
Period	Spike #	Concentration of CH3CHO Cylinder	Stack CO2 Concentration	Stack CH3CHO Concentration	Stack + Spike CO2 Concentration	Stack + CH3CHO Concentration	DF Calculated	% Recovery CH3CHO
PRE TEST	1	28.6	7.2	-0.9	6.5	2.0	0.091	109.5%

PRE SYSTEM CAL			
Sensor	System Response (ppm)	Cal Level (ppm)	Cal Recovery (%)
NOx	494.1	509.7	-3.1
CO	485.9	503.0	-3.4
Propane	493.6	503.2	-1.9
*Ethylene	98.2	100.0	-1.8
Acetaldehyde	28.1	28.6	-1.9

PRE DIRECT CAL				
Sensor	Analyzer Response (ppm)	Cal Level (ppm)	Zero Response (ppm)	Cal Error (%)
				Zero Error (%)
NOx	507.8	509.7	0.4	-0.4
CO	503.1	503.0	-0.1	0.01
Propane	505.7	503.2	0.4	0.5
Ethylene	99.3	100.0	-0.4	-0.7
Acetaldehyde	28.8	28.6	-0.4	0.6
				-1.4

POST DIRECT CAL				
Sensor	Analyzer Response (ppm)	Cal Level (ppm)	Zero Response (ppm)	Cal Error (%)
				Zero Error (%)
NOx	509.9	509.7	0.3	0.03
CO	503.9	503.0	0.1	0.2
Propane	505.2	503.2	0.4	0.4
Acetaldehyde	28.7	28.6	0.4	0.4
				1.4

POST SYSTEM CAL			
Sensor	System Response (ppm)	Cal Level (ppm)	Cal Recovery (%)
*Ethylene	97.2	100.0	-2.8

\*CTS Scans are conducted with Ethylene through the sample line.

**Airgas Specialty Gases**

12722 South Wentworth Avenue

Chicago, IL 60628

(773)785-3000 Fax: (773) 785-1928

www.airgas.com

## CERTIFICATE OF ANALYSIS Grade of Product: EPA Protocol

Part Number: E05NI99E15A0000 Reference Number: 54-124365634-3  
Cylinder Number: CC326672 Cylinder Volume: 144.4 CF  
Laboratory: ASG - Chicago - IL Cylinder Pressure: 2015 PSIG  
PGVP Number: B12013 Valve Outlet: 660  
Gas Code: CH4,CO,NO,PPN Certification Date: Apr 02, 2013

Expiration Date: Apr 02, 2021

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

**ANALYTICAL RESULTS**

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	500.0 PPM	509.7 PPM	G1	+/- 0.8% NIST Traceable	03/22/2013, 04/02/2013
CARBON MONOXIDE	500.0 PPM	503.0 PPM	G1	+/- 1.0% NIST Traceable	03/22/2013
METHANE	500.0 PPM	508.7 PPM	G1	+/- 0.9% NIST Traceable	03/25/2013
NITRIC OXIDE	500.0 PPM	509.7 PPM	G1	+/- 0.8% NIST Traceable	03/22/2013, 04/02/2013
PROPANE	500.0 PPM	503.2 PPM	G1	+/- 1% NIST Traceable	03/27/2013
NITROGEN	Balance				

**CALIBRATION STANDARDS**

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	12062429	CC366885	487.1 PPM CARBON MONOXIDE/NITROGEN	+/- 0.6%	Jun 22, 2018
NTRM/CH4	10060916	CC321243	500.5 PPM METHANE/NITROGEN	+/- 0.6%	Aug 07, 2016
NTRM/NO	12061034	CC359504	500.7 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	Feb 16, 2018
NO2	124206889130	CC323209	4.824 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Oct 25, 2015
NTRM	10060514	CC281296	495.3 PPM PROPANE/AIR	+/- 0.5%	Feb 19, 2016

**ANALYTICAL EQUIPMENT**

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nexus 470 AEP0000428	FTIR	Mar 04, 2013
Nicolet 6700 AHR0801332	FTIR	Feb 27, 2013
Nexus 470 AEP0000428	FTIR	Mar 04, 2013
Nexus 470 AEP0000428	FTIR	Mar 04, 2013
(V-1)VARIAN CP3800 FID	FID	Mar 25, 2013

Triad Data Available Upon Request

Notes:



# CERTIFICATE OF ANALYSIS

## Grade of Product: EPA Protocol

Airgas Specialty Gases  
12722 South Wentworth Avenue  
Chicago, IL 60628  
(773) 785-3000 Fax: (773) 785-1928  
[www.airgas.com](http://www.airgas.com)

Part Number: E03NI99E15A2059 Reference Number: 54-124310141-1  
Cylinder Number: SG9164386BAL Cylinder Volume: 144 Cu.Ft.  
Laboratory: ASG - Chicago - IL Cylinder Pressure: 2015 PSIG  
PGVP Number: B12012 Valve Outlet: 660  
Gas Code: NO2 Analysis Date: Apr 04, 2012

Expiration Date: Apr 04, 2014

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1997)" using the assay procedures listed. Analytical Methodology does not require correction for analytical interferences. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.  
Do Not Use This Cylinder below 150 psig.i.e. 1 Mega Pascal

ANALYTICAL RESULTS				
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
NITROGEN DIOXIDE	150.0 PPM	148.5 PPM	G1	+/- 2%
NITROGEN	Balance			
CALIBRATION STANDARDS				
Type	Lot ID	Cylinder No	Concentration	Expiration Date
GMIS/NO2	124185475102	CC316732	196.5PPM NITROGEN DIOXIDE/NITROGEN	Nov 16, 2013
ANALYTICAL EQUIPMENT				
Instrument/Make/Model	Analytical Principle			Last Multipoint Calibration
(CH-3) ECO PHYSICS CLD822S	Chemiluminescence			Mar 11, 2012

Triad Data Available Upon Request

Notes:

Approved for Release

**CERTIFICATE OF ANALYSIS****Grade of Product: PRIMARY STANDARD**

Part Number:	X02NI99P15AD524	Reference Number:	54-124365634-5
Cylinder Number:	CC29694	Cylinder Volume:	144.4 CF
Laboratory:	ASG - Chicago - IL	Cylinder Pressure:	2015 PSIG
Analysis Date:	Mar 21, 2013	Valve Outlet:	350
Lot Number:	54-124365634-5		

Primary Standard Gas Mixtures are traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

**ANALYTICAL RESULTS**

Component	Requested Concentration	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE	100.0 PPM	100.0 PPM	+/- 1%
NITROGEN	Balance		

Notes:

Approved for Release

## CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Part Number: X02NI99C15AC0A0      Reference Number: 83-124365607-1  
Cylinder Number: SG9148093BAL      Cylinder Volume: 144.4 CF  
Laboratory: ASG - Port Allen - LA      Cylinder Pressure: 2015 PSIG  
Analysis Date: Apr 02, 2013      Valve Outlet: 350  
Lot Number: 83-124365607-1

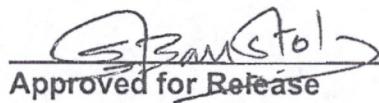
Expiration Date: Apr 02, 2014

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

### ANALYTICAL RESULTS

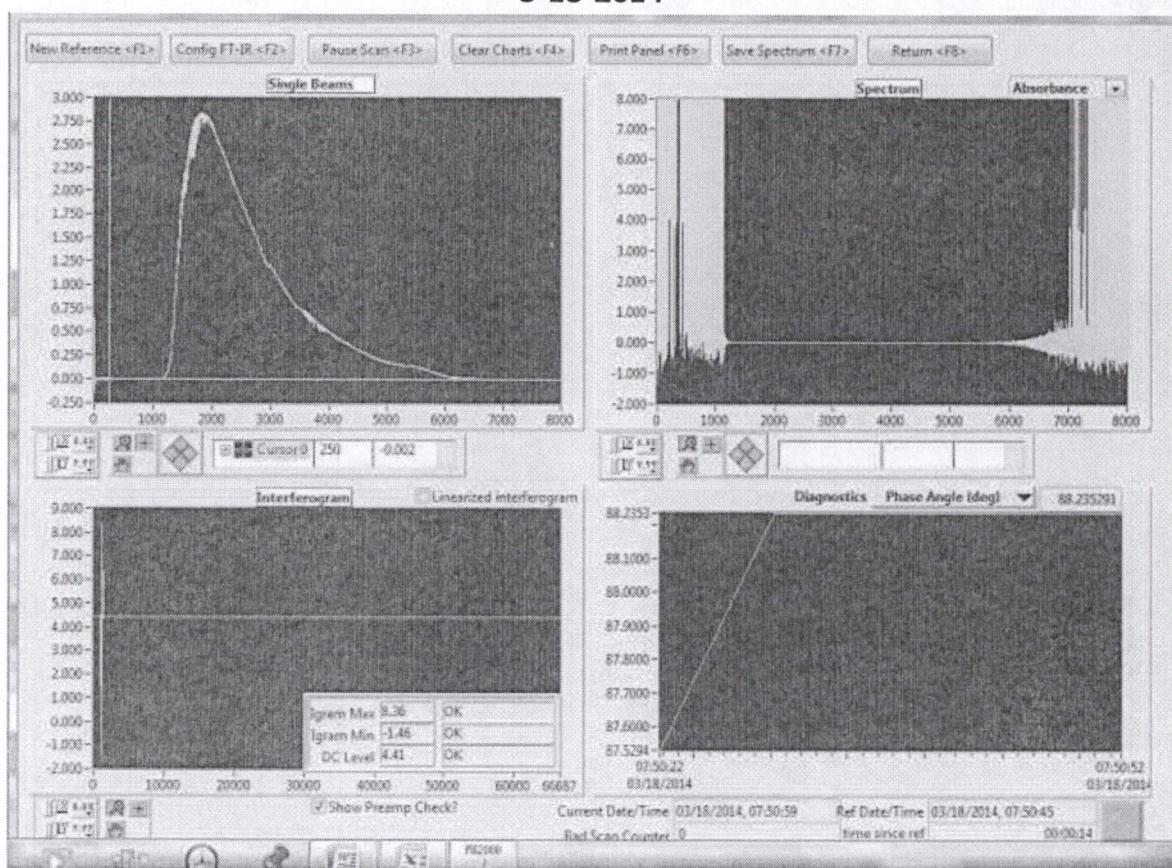
Component	Requested Concentration	Actual Concentration (Mole %)	Analytical Uncertainty
ACETALDEHYDE	30.00 PPM	28.61 PPM	+/- 5%
NITROGEN	Balance		

Notes:

  
Approved for Release

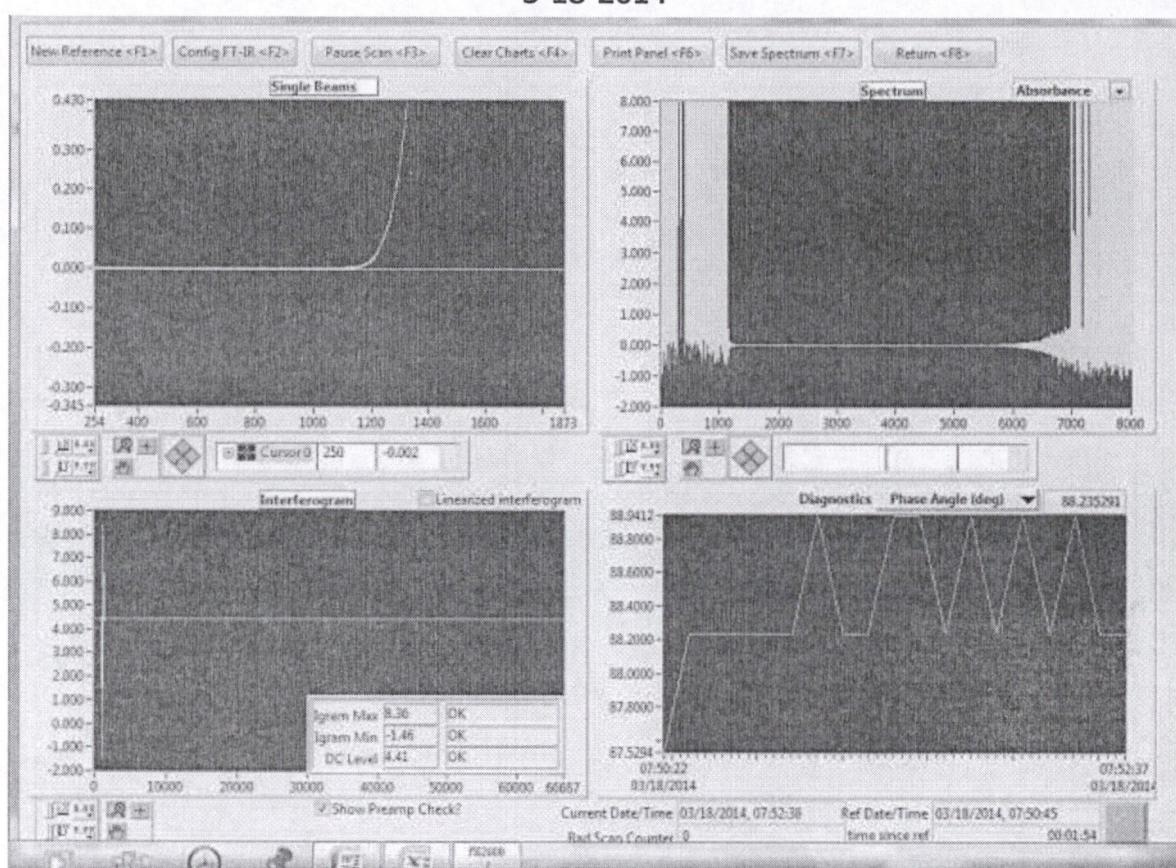
# XTO – RBU 11-18F #2

3-18-2014



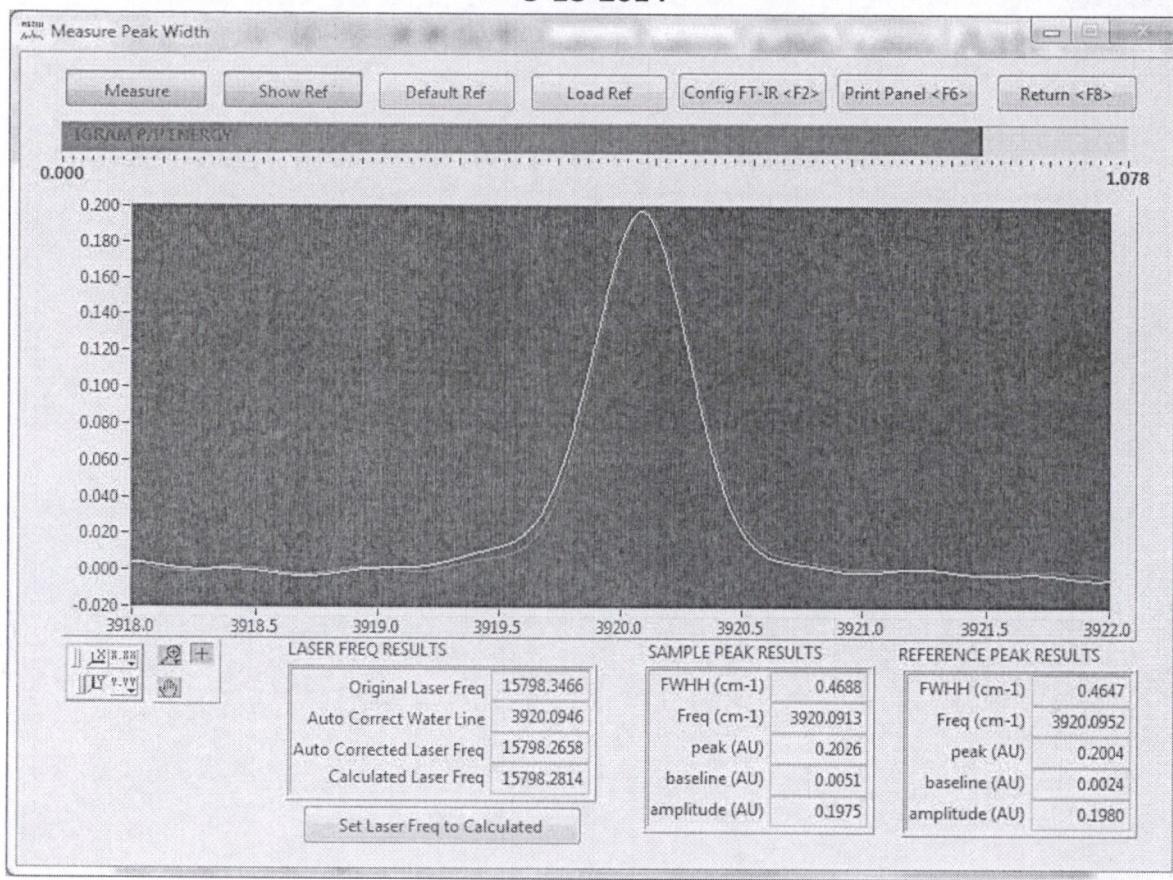
# XTO – RBU 11-18F #2

3-18-2014



## XTO – RBU 11-18F #2

3-18-2014



**Instrument Resolution** – FWHH – 0.4688 cm<sup>-1</sup> which is < 0.55 cm<sup>-1</sup> (therefore meets ASTM)  
**Water Frequency** – Freq – 3920.0913 cm<sup>-1</sup> which is +/- 0.075 of 3920.0952 cm<sup>-1</sup> (therefore meets ASTM)

**Please note:** FWHH is the Full Width at Half Height of the resolution. The frequency position is only calculating the center line for one water line in the spectrum. MKS uses 3920.0952 cm<sup>-1</sup> since it is a single water line.

CO/NO/NO2/Formaldehyde FTIR Instrument Noise-Limited Minimum Detectable Concentration - MDC#2

Noise Equivalent Absorbance Data				
Spectrum	CO	NO	NO2	Formaldehyde
XTO RBU 11-18 E2 3-18-14_000004.LAB	-0.02	0.02	0.02	-0.08
XTO RBU 11-18 E2 3-18-14_000005.LAB	0.10	0.00	0.00	-0.02
XTO RBU 11-18 E2 3-18-14_000006.LAB	0.10	-0.10	0.05	-0.03
XTO RBU 11-18 E2 3-18-14_000007.LAB	0.16	0.05	-0.02	-0.07
XTO RBU 11-18 E2 3-18-14_000008.LAB	0.08	0.11	-0.04	0.02
XTO RBU 11-18 E2 3-18-14_000009.LAB	0.05	-0.05	-0.03	-0.08
XTO RBU 11-18 E2 3-18-14_000010.LAB	0.06	0.16	0.00	-0.16
XTO RBU 11-18 E2 3-18-14_000011.LAB	0.09	-0.14	-0.02	-0.07
XTO RBU 11-18 E2 3-18-14_000012.LAB	0.11	-0.01	-0.10	-0.02
XTO RBU 11-18 E2 3-18-14_000013.LAB	-0.02	0.03	-0.04	-0.01
<b>Noise Equivalent Absorbance (Standard Deviation)</b>	<b>0.05</b>	<b>0.08</b>	<b>0.04</b>	<b>0.05</b>
<b>MDC #2</b>	<b>0.16</b>	<b>0.25</b>	<b>0.11</b>	<b>0.15</b>

## **APPENDIX C**

# G3516

GAS COMPRESSION APPLICATION

## GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - RBU 11-18F #2

**CATERPILLAR®**

ENGINE SPEED (rpm):	1357	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8:1	RATING LEVEL:	CONTINUOUS
AFTERCooler TYPE:	SCAC	FUEL SYSTEM:	HPG IMPCO
AFTERCooler WATER INLET (°F):	130		WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA	FUEL:	Field Gas
COOLING SYSTEM:	JW+OC, AC	FUEL PRESSURE RANGE(psig):	35.0-40.0
CONTROL SYSTEM:	ADEM3	FUEL METHANE NUMBER:	62.2
EXHAUST MANIFOLD:	ASWC	FUEL LHV (Btu/scf):	1027
COMBUSTION:	LOW EMISSION	ALTITUDE(ft):	5278
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0	MAXIMUM INLET AIR TEMPERATURE(°F):	47
SET POINT TIMING:	27	STANDARD RATED POWER:	1340 bhp@1400rpm

RATING	NOTES	LOAD	100%	100%	75%	52%
ENGINE POWER INLET AIR TEMPERATURE	(WITHOUT FAN)	(1) bhp °F	1299 42	1284 47	963 47	670 47

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7700	7710	7943	8411
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8508	8519	8777	9294
AIR FLOW (@inlet air temp, 14.7 psia)	(WET) (3)(4)	ft3/min	2580	2577	1943	1388
AIR FLOW	(WET) (3)(4)	lb/hr	12239	12104	9125	6518
FUEL FLOW (60°F, 14.7 psia)	(5)	scfm	162	161	124	91
INLET MANIFOLD PRESSURE	(5)	in Hg(abs)	68.9	68.3	53.8	39.7
EXHAUST TEMPERATURE - ENGINE OUTLET	(6)	°F	907	907	906	909
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET) (7)(4)	ft3/min	7599	7515	5671	4069
EXHAUST GAS MASS FLOW	(WET) (7)(4)	lb/hr	12720	12580	9494	6789

EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)(9)	g/bhp-hr	2.25	2.26	2.36	2.51
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.43	2.43	2.54	2.68
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.63	0.66	0.69
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.42	0.44	0.47
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.23
CO2	(8)(9)	g/bhp-hr	507	508	516	540
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.7	7.5

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42499	42235	35212	29328
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5150	5111	4263	3488
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6338	6299	5251	4374
HEAT REJ. TO AFTERCooler (AC)	(12)(13)	Btu/min	8758	8758	5404	2003

COOLING SYSTEM SIZING CRITERIA			
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	54354
TOTAL AFTERCooler CIRCUIT (AC)	(13)(14)	Btu/min	9196

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

### CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 1 - intake man press -> 33 psi -> 67.19 in Hg

Pabs = 67.19 in Hg

by linear interpolation, est BHP => 1259.4 BHP

# G3516

GAS COMPRESSION APPLICATION

## GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - RBU 11-18F #2



ENGINE SPEED (rpm):	1345	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8:1	RATING LEVEL:	CONTINUOUS
AFTERCooler TYPE:	SCAC	FUEL SYSTEM:	HPG IMPCO
AFTERCooler WATER INLET (°F):	130		WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA		
COOLING SYSTEM:	JW+OC, AC	FUEL:	Field Gas
CONTROL SYSTEM:	ADEM3	FUEL PRESSURE RANGE(psig):	35.0-40.0
EXHAUST MANIFOLD:	ASWC	FUEL METHANE NUMBER:	62.2
COMBUSTION:	LOW EMISSION	FUEL LHV (Btu/scf):	1027
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0	ALTITUDE(ft):	5278
SET POINT TIMING:	27	MAXIMUM INLET AIR TEMPERATURE(°F):	45
		STANDARD RATED POWER:	1340 bhp@1400rpm

RATING	(WITHOUT FAN)	NOTES	LOAD	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE			
				100%	100%	75%	52%
ENGINE POWER		(1)	bhp	1287	1280	960	670
INLET AIR TEMPERATURE			°F	42	45	45	45

ENGINE DATA							
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7694	7699	7926	8382	
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8501	8507	8758	9261	
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	(3)(4)	2555	2554	1925	1377	
AIR FLOW	(WET)	(3)(4)	lb/hr	12108	12042	9074	6493
FUEL FLOW (60°F, 14.7 psia)			scfm	161	160	123	91
INLET MANIFOLD PRESSURE			in Hg(abs)	68.6	68.3	53.8	39.8
EXHAUST TEMPERATURE - ENGINE OUTLET		(5)	°F	907	907	906	909
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(6)	ft3/min	7517	7476	5638	4052
EXHAUST GAS MASS FLOW	(WET)	(7)(4)	lb/hr	12585	12517	9441	6763

EMISSIONS DATA - ENGINE OUT							
NOx (as NO2)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00	
CO	(8)(9)	g/bhp-hr	2.24	2.24	2.34	2.49	
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.42	2.43	2.53	2.66	
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.63	0.66	0.69	
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.42	0.44	0.46	
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.23	
CO2	(8)(9)	g/bhp-hr	506	507	515	538	
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.7	7.5	

HEAT REJECTION							
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42193	42065	35014	29179	
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5104	5086	4240	3473	
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6293	6273	5222	4352	
HEAT REJ. TO AFTERCOOLER (AC)	(12)(13)	Btu/min	8567	8567	5333	1976	

COOLING SYSTEM SIZING CRITERIA							
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	53963				
TOTAL AFTERCOOLER CIRCUIT (AC)	(13)(14)	Btu/min	8995				

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

**CONDITIONS AND DEFINITIONS**  
 Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 2 - intake man press -> 34 psi -> 69.22 in Hg

Pabs = 69.22 in Hg

Unit exceeds scale of heat balance table  
 assume running at maximum rated load -> 1287 BHP

# G3516

GAS COMPRESSION APPLICATION

## GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - RBU 11-18F #2



ENGINE SPEED (rpm):	1352	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8:1	RATING LEVEL:	CONTINUOUS
AFTERTOOLER TYPE:	SCAC	FUEL SYSTEM:	HPG IMPCO
AFTERTOOLER WATER INLET (°F):	130		WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA		
COOLING SYSTEM:	JW+OC, AC	FUEL:	Field Gas
CONTROL SYSTEM:	ADEM3	FUEL PRESSURE RANGE(psig):	35.0-40.0
EXHAUST MANIFOLD:	ASWC	FUEL METHANE NUMBER:	62.2
COMBUSTION:	LOW EMISSION	FUEL LHV (Btu/scf):	1027
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0	ALTITUDE(ft):	5278
SET POINT TIMING:	27	MAXIMUM INLET AIR TEMPERATURE(°F):	37
		STANDARD RATED POWER:	1340 bhp@1400rpm

RATING	NOTES	LOAD	100%	100%	75%	52%
ENGINE POWER (WITHOUT FAN)	(1)	bhp °F	1294 37	1294 37	970 37	670 37

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7697	7697	7923	8399
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8505	8505	8754	9280
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	ft3/min	2545	2543	1916	1358
AIR FLOW	(WET)	lb/hr	12185	12185	9181	6507
FUEL FLOW (60°F, 14.7 psia)	(3)(4)	scfm	162	162	125	91
INLET MANIFOLD PRESSURE	(5)	in Hg(abs)	68.8	68.8	54.2	39.7
EXHAUST TEMPERATURE - ENGINE OUTLET	(6)	°F	907	907	906	909
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	ft3/min	7565	7565	5704	4062
EXHAUST GAS MASS FLOW	(WET)	lb/hr	12664	12664	9552	6778

EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)(9)	g/bhp-hr	2.25	2.25	2.35	2.50
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.43	2.43	2.53	2.67
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.63	0.66	0.69
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.42	0.44	0.47
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.23
CO2	(8)(9)	g/bhp-hr	507	507	515	539
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.8	7.5

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42369	42369	35228	29266
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5131	5131	4276	3482
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6319	6319	5254	4365
HEAT REJ. TO AFTERCOOLER (AC)	(12)(13)	Btu/min	8678	8678	5494	1992

COOLING SYSTEM SIZING CRITERIA						
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	54189			
TOTAL AFTERCOOLER CIRCUIT (AC)	(13)(14)	Btu/min	9111			

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

### CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 3 - intake man press -> 34 psi -> 69.22 in Hg

Pabs = 69.22 in Hg

Unit exceeds scale of heat balance table  
assume running at maximum rated load -> 1294 BHP

## **APPENDIX D**

# FTIR Engine Test Sheet

Company Name	XTO
Location / Unit I.D.	RBL 11-18 E2
Type of Test Completed:	NOx, CO, HC/CO 3-1hr JPT
Field Technician (s)	Van, David
Client Rep and/or State Rep	Derrick - XTO
Date:	3-18-14

	Test 1	Test 2	Test 3
Time of Readings	3:30	4:15 pm	5:15 AM
Atm Pressure (in Hg)	24.87	24.86	24.84
Atm Temp (°F)	47°	45°	37°
Engine RPM	1357	1345	1352
*Manifold Pres. <del>Accel</del> or Boost(psi)	33	34	34
Manifold Temp (°F)	130°	133°	131°
Psuction (psi) Stage 1	31	32	32
Tsuction (°F) Stage 1	37°	39°	42°
Pdischarge (psi) Stage 1	140	137	141
Psuction (psi) Stage 2	140	137	141
Tsuction (°F) Stage 2	48°	50°	52°
Pdischarge (psi) Stage 2	410	420	421
Psuction (psi) Stage 3	410	420	421
Tsuction (°F) Stage 3	70°	66°	65°
Pdischarge (psi) Stage 3	1067	1061	1064
Psuction (psi) Stage 4			
Tsuction (°F) Stage 4			
Pdischarge (psi) Stage 4			
Gas Throughput (mmcf/d)			
Pre CO (ppm)			
Pre Cat Temp (°F)	758°	757°	750°
Post Cat Temp (°F)			
Cat Differential Pres. (* of H2O)	12"	12"	12"
Impinger 1 (grams)	1	1	1
Impinger 2 (grams)	1	1	1
Impinger 3 (grams)	1	1	1
Impinger 4 (grams)	1	1	1
Dry Gas Meter (cubic ft)	1	1	1
DGM Inlet Temp (deg F)	1	1	1
DGM Outlet Temp (deg F)	1	1	1
O2 %	8.6%	8.5%	8.5%
CO2 %	7.1%	7.1%	7.1%
LOAD %			
Delta H			
Ignition Timing (°F)	28°	27.9°	27.9°
AFR Setting mV (Left Bank)			
AFR Setting mV (Right Bank)			
Upstream Port Distance (pd)	20"		
Downstream Port Distance (pd)	36"		
Exhaust Diameter (inches)	12"		Cylinder Serial #↓
Propane	503.2		
NO	509.7		
CO	503		
NO2	148.5		
Ethylene	100		
Methane	509.7		
Acetaldehyde	28.61		
Engine Make	CAT		
Engine Model	3516LE		
Engine S/N	WPW00339		

\* Some units show boost in inches of Hg. In this situation please indicate if it is positive (+) or negative (-). Eg: (+12") or (-5")

Rev 5

5/25/2011

Max load as per mechanic.

XTO  
RBU 11-18 E2  
3-18-14

TEST RUN /

Stack Diameter		12	Inches	Kp=	EPA REFERENCE		Cp=	0.84		
Traverse Points		16		Port	Point	85.49 ft/sec	dP	Ts	Stat P	
Ports		2				Insertion Depth(Inches)	(in h2O)	(deg R)	(in H2O)	Static
Average O2		8.6	(% dry)	A	1	.38	4.01	708	1.46	
Average CO2		7.1	(% dry)	A	2	1.26	3.76			
Average N2 + CO			(% dry)	A	3	2.33	3.21			
Dry Molecular Weight			lb/lbmol	A	4	3.88	3.11			
Wet Molecular Weight			lb/lbmol	A	5	8.12	2.95			
				A	6	9.67	2.91			
				A	7	10.74	3.01			
Barometric Pressure		24.87	in Hg	A	8	11.62	4.00			
Gas Meter Constant				A	9					
Gas Volume Constant			deg R/in Hg	A	10					
Dry Gas Volume			dscf	A	11					
Water Vapor Volume			scf	A	12					
Moisture Content			%	A	13					
				A	14					
Dry Gas Met. Vol			dscf	A	15					
Gas Met. Inlet Temp.			deg F	A	16					
Gas Met. Outlet Temp.			deg F	B	1	.38	4.03			
Mass Liquid H2O			grams	B	2	1.26	3.81			
Mass Of Silica Gel			grams	B	3	2.33	3.67			
				B	4	3.88	3.30			
Average Analyzer NOx Level			ppm	B	5	8.12	2.38			
Average Corrected NOx Level			ppm	B	6	9.67	3.05			
Calculated NOx Mass Output			lbs/hr	B	7	10.74	3.44			
Calculated NOx Output			gr/BHP-hr	B	8	11.62	3.77			
				B	9					
Average Analyzer CO Level			ppm	B	10					
Average Corrected CO Level			ppm	B	11					
Calculated CO Mass Output			lbs/hr	B	12					
Calculated CO Output			gr/BHP-hr	B	13					
				B	14					
Average Analyzer NMHC Level			ppm	B	15					
Average Corrected NMHC Level (wet)			ppm	B	16					
Average Corrected NMHC Level (dry)			ppm							
Calculated NMHC Mass Output			lbs/hr							
Calculated NMHC Output			gr/BHP-hr							
IMPINGER DATA	1	2	3	4						

XTO  
RBM 11-18 EZ  
3-18-14

TEST RUN 2

					EPA REFERENCE			Cp= 0.84	
Stack Diameter	12	Inches	Kp=	METHOD 2	85.49 ft/sec	dP	Ts	Stat P	
Traverse Points	16		Port	Point	Insertion Depth(inches)	(in H <sub>2</sub> O)	(deg R)	(in H <sub>2</sub> O)	Static
Ports	2		A	1	.38	3.96	704	1.40	
Average O <sub>2</sub>	8.5	(% dry)	A	2	1.26	3.80			
Average CO <sub>2</sub>	7.1	(% dry)	A	3	2.33	3.16			
Average N <sub>2</sub> + CO		(% dry)	A	4	3.88	3.10			
Dry Molecular Weight		lb/lbmol	A	5	8.12	2.90			
Wet Molecular Weight		lb/lbmol	A	6	9.67	2.84			
			A	7	10.74	2.96			
Barometric Pressure	24.86	in Hg	A	8	11.62	3.78			
Gas Meter Constant			A	9					
Gas Volume Constant		deg R/in Hg	A	10					
Dry Gas Volume		dscf	A	11					
Water Vapor Volume		scf	A	12					
Moisture Content		%	A	13					
			A	14					
Dry Gas Met. Vol.		dscf	A	15					
Gas Met. Inlet Temp.		deg F	A	16					
Gas Met. Outlet Temp.		deg F	B	1	.38	3.90			
Mass Liquid H <sub>2</sub> O		grams	B	2	1.26	3.74			
Mass Of Silica Gel		grams	B	3	2.33	3.60			
			B	4	3.88	3.39			
Average Analyzer NO <sub>x</sub> Level		ppm	B	5	8.12	3.46			
Average Corrected NO <sub>x</sub> Level		ppm	B	6	9.67	3.13			
Calculated NO <sub>x</sub> Mass Output		lbs/hr	B	7	10.74	3.40			
Calculated NO <sub>x</sub> Output		gr/BHP-hr	B	8	11.62	3.64			
			B	9					
Average Analyzer CO Level		ppm	B	10					
Average Corrected CO Level		ppm	B	11					
Calculated CO Mass Output		lbs/hr	B	12					
Calculated CO Output		gr/BHP-hr	B	13					
			B	14					
Average Analyzer NMHC Level		ppm	B	15					
Average Corrected NMHC Level (wet)		ppm	B	16					
Average Corrected NMHC Level (dry)		ppm							
Calculated NMHC Mass Output		lbs/hr							
Calculated NMHC Output		gr/BHP-hr							

XIO  
RBM 11-18 E2

3-18-14

TEST RUN 3

Stack Diameter	12	Inches	Kp=	EPA REFERENCE		Cp=	0.84		
Traverse Points	16		Port	Point	85.49 ft/sec	dP	Ts	Stat P	
Ports	2				Insertion Depth(inches)	(In h2O)	(deg R)	(In H2O)	Static
Average O2	8.5	(% dry)	A	1	.38	4.04	700'	1.50	
Average CO2	7.1	(% dry)	A	2	1.26	3.73			
Average N2 + CO		(% dry)	A	3	2.33	3.76			
Dry Molecular Weight		lb/lbmol	A	4	3.88	3.04			
Wet Molecular Weight		lb/lbmol	A	5	8.12	2.96			
Barometric Pressure	24.94	In Hg	A	6	9.67	2.81			
Gas Meter Constant			A	7	10.74	3.13			
Gas Volume Constant			A	8	11.62	3.70			
Dry Gas Volume		dscf	A	9					
Water Vapor Volume		scf	A	10					
Moisture Content		%	A	11					
			A	12					
Dry Gas Met. Vol		dacf	A	13					
Gas Met. Inlet Temp.		deg F	A	14					
Gas Met. Outlet Temp.		deg F	B	15	.38	3.97			
Mass Liquid H2O		grams	B	16	1.26	3.82			
Mass Of Silica Gel		grams	B	1	2.33	3.71			
			B	2					
Average Analyzer NOx Level		ppm	B	3	3.88	3.43			
Average Corrected NOx Level		ppm	B	4	8.12	3.32			
Calculated NOx Mass Output		lbs/hr	B	5	9.67	3.09			
Calculated NOx Output		gr/BHP-hr	B	6	10.74	3.46			
			B	7	11.62	3.71			
Average Analyzer CO Level		ppm	B	8					
Average Corrected CO Level		ppm	B	9					
Calculated CO Mass Output		lbs/hr	B	10					
Calculated CO Output		gr/BHP-hr	B	11					
Average Analyzer NMHC Level		ppm	B	12					
Average Corrected NMHC Level (wet)		ppm	B	13					
Average Corrected NMHC Level (dry)		ppm	B	14					
Calculated NMHC Mass Output		lbs/hr	B	15					
Calculated NMHC Output		gr/BHP-hr	B	16					
IMPINGER DATA	1			3					
	2				4				